NATIONAL UNIVERSITY OF ENGINEERING

COLLEGE OF GEOLOGICAL, MINING AND METALLURGICAL ENGINEERING

MINING ENGINEERING PROGRAM

MI565 – ROCK BLASTING

I. GENERAL INFORMATION

CODE	**:**	MI565 Rock Blasting
SEMESTER	**:**	9
CREDITS	**:**	3
HOURS PER WEEK	**:**	4 (Theory–Practice)
PREREQUISITES	**:**	MI861 Design of Mining Plants MI872 Surface Mining Exploitation Methods
CONDITION	**:**	Compulsory
DEPARTMENT	**:**	Mining Engineering

II. COURSE DESCRIPTION

The course prepares students for understanding and analyzing the physical and chemical components, characteristics, properties and modeling of commercial explosives, commonly used in mining such as: black gunpowder, dynamite, ANFO, ALANFO, SANFO, Slurry and Emulsion explosives, heavy ANFO and ANCO. Students calculate detonation and explosion parameters of any commercial explosive mixture by the use of thermo-hydrodynamical theory and mathematical modeling of rocks blasting. Also, realize the fragmentation, production and productivity optimization and operational costs minimization.

III. COURSE OUTCOMES

At the end of the course, students:

1. Understand rock and soil dynamics and behavior when an opening is made taking into account rock properties and opening methods.
2. Explain the mechanical behavior of rock mass, as well as analyze the control of deformations.
3. Apply methods and techniques for predicting rock as soil deformations.
4. Understand the process of generation of arc effect and calibrate it according to drilling methods, and stress and stability conditions.
5. Organize tunnel construction activities using methods of drilling and blasting.
6. Determine and size the required equipment and resources for tunnel construction and maintenance.
7. Apply proper methods for assuring tunnel stability and safety along the mining operation time span.

IV. LEARNING UNITS

1. INTRODUCTION

History and technological evolution / Mining applications / Tunnel construction processes / Trends in tunnel construction technology / Megaprojects / Tunnel construction using modern technologies.

2. TUNNEL CONSTRUCTION PROCESS

Arc effect / The mean: rocks and soils / Behavior of the means subject to stress / Geomechanic behavior classification / Action and reaction / Mean perturbation / Influence

radius / Deformation as mean response / Over break / Tunnel construction methods / Drilling and excavation methods.

3. MEAN DEFORMATION

Deformation behavior at the top, side and bottom of the tunnel / Extrusion / Pre-convergence / Convergence / Deformation behavior and opening size / Deformation analysis / Methods for controlling deformations / Pre-confinement / Confinement.

4. DEFORMATION PREDICTION AND CONTROL

Methods and procedures / Solid load method / Block theory / Plastic band method / Characteristic line method / Numeric analysis / Finite elements / tunnel instability by stability structures / Portico / Forward and backward control.

5. TUNNEL DESIGN

Possible events in rock mass / Recognition phase / Recognition for conventional excavation / Area hydrogeological and morphological characteristics / Terrain definition at tunnel axis / Geological and tectonic structures and stress state of rock mass / Hydrogeological regime of rock mass / Geomechanical characteristics / Excavation with TBM / Pilot tunnel / Geophysical methods / Operational decisions / Conventional mechanized excavations / Tunnel design using conventional excavation / Intervention for stabilization / Pre-confinement intervention / Shortcrete coating / Reinforcement with glass fiber structural elements / Truncated cone / Cell arc technology / Confinement intervention / Shortcrete for preliminary coating / Radial screwing / Inverted tunnel.

6. OPERATIONAL PHASE WITH CONVENTIONAL METHOD

Tunnels construction stages with drilling and blasting / Working cycle / Drilling / Driller classification / Drilling accessories / Blasting / Explosive and accessories / Fragmentation process / Drilling nets / Blasting sequence / Explosive types / Tunnel drilling and blasting / Chimney construction methods / Tunnel ventilation / Tunnel cleaning / Load transport equipment / Working cycle times / Steel arcs / Anchorage screws / Bars and cables / Mechanical anchorage / Dry and humid roads / Safety during construction / Environmental care.

7. BURDEN CALCULATION

Mathematical models to calculate the proper burden / Primary firing design for surface mining / Ash model / Pearse model / Primary firing design for underground mining / Langerfors model / Hagan and Holmberg model / Cuts. / Angular drilled cuts / Parallel drilled cuts / Equivalent empty drill / Burning cut / Coromant cut / Application problems.

8. BLASTABILITY INDEX

Introduction / Blastability index by Ash / Blastability index by Lillys. / Blastability index by Afrouz. / Blastability index by Borquez.

9. ROCKS FRACTURING PROCESS

Definition / Evolution of rocks fracturing process / Stages of the rocks fracturing process / Description analysis and discussion: American school vs European school / Controlled blasting / Introduction / Analysis and discussion of controlled blasting principal techniques / In-line drilling / Precut / Cut / Smooth blasting / Cushioned blasting / Soft blasting / Application problems.

V. METHODOLOGY

This course is organized in sessions of theory, practice and computer laboratory. In theory sessions the concepts and applications are explained. In practice sessions, real cases related to extractive metallurgy are analyzed and students propose solutions. In laboratory sessions, specialized software is used for analyzing and simulating blasting processes and explosives performance.

VI. GRADING FORMULA

The Final Grade PF is calculated as follow:

PF = (EP + 2*EF) / 3

EP: Mid-term Exam EF: Final Exam

VII. BIBLIOGRAPHY

1. COOK M.
   The Science of High Explosives. N.Y., 2011.
2. AGREDA, C.
   Controlled blasting. Theory and applications, Lima, Peru, 2002.